OREST PEST MANAGEMENT

BIOLOGICAL EVALUATION
R2-92-01

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HREE YEARS AFTER THE CLOVER MIST FIRE
ON THE CLARKS FORK RANGER DISTRICT,
SHOSHONE NATIONAL FOREST, WYOMING

MARCH 1992

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Forest Pest Management
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POPULATIONS OF DOUGLAS-FIR BEETLE IN GREEN TREES THREE YEARS AFTER THE CLOVER MIST FIRE ON THE CLARKS FORK RANGER DISTRICT, SHOSHONE NATIONAL FOREST, WYOMING

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ABSTRACT

Brood densities of Douglas-fir beetle (DFB), Dendroctonus pseudotsugae Hopkins, in green trees adjoining areas burned by the 1988 Clover Mist Fire varied by site, but averaged 8 per 36 sq. in. for bark samples at all sites examined during November 1991. Brood densities were much reduced from 1990 levels, but were similar to densities found in blackened trees in fall 1989. The reduction from 1990 levels was attributed to heavy winter mortality of brood caused by prolonged extreme cold temperatures. Most brood in fall 1991 samples was present in the callow adult stage, similar to 1989 samples, and in contrast to 1990 samples when many immatures were detected. Gallery starts and total gallery length per 36 sq. in. bark sample averaged 2.3 and 23 in., respectively, indicating high attack densities and full occupancy of the food resource. About 2-3 DFB survived to fall 1991 per attacking female. Natural enemies were 10-40 times more abundant in bark samples in fall 1991 compared to fall 1990.

In the absence of severe winter temperatures, the DFB population can be expected to increase 1.5 to 3 times from 1991 to 1992. Management alternatives to reduce the impact of the DFB epidemic are discussed and prompt treatment of infested trees is recommended where feasible.

INTRODUCTION

During August 1988, the catastrophic Clover Mist Fire entered the Shoshone National Forest in Wyoming from Yellowstone National Park, sweeping across much of the North Absaroka Wilderness and into the Clarks Fork Ranger District, generally south of U.S. Highway 212 and Wyoming Route 296 (Forest Route 100). The hot, wind-driven fire destroyed extensive acreages of mixed conifer stands, composed predominately of lodgepole pine (*Pinus contorta* Dougl. ex Loud.), Engelmann spruce (*Picea engelmannii* Perry ex Engelm.), and Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco). Nearly pure stands and pockets of dense, mature or overmature Douglas-fir occur in areas near the fire boundary within the suitable timber base on the Clarks Fork Ranger District. Douglas-fir stands average more than 120 years of age and trees are nearly 200 years old at Cathedral Cliffs.

During visits to burned areas in summer and fall of 1989, entomologists determined that large numbers of the Douglas-fir beetle, *Dendroctonus pseudotsugae* Hopkins (Coleoptera: Scolytidae), were present in large-diameter, blackened Douglas-fir trees (Pasek, 1990). Although half the bark samples (6 in. by 6 in.) from infested trees contained no DFB brood, average brood production for all samples was 9 and 7 callow adults per sample, respectively, at Cathedral Cliffs and Squaw Creek.

Observations during summer 1990 indicated an epidemic of DFB was developing in scorched and green Douglas-fir adjoining the fire boundary and in small pockets located at relatively short distances from the fire boundary. Infestations were detected at Sugarloaf Mountain, Camp Creek, Upper Reef Creek, Cathedral Cliffs, Squaw Creek, Russell Peak, and Pahaska Tepee on the North Fork of the Shoshone River (Wapiti Ranger District). Most, if not all, areas of large-diameter Douglas-fir adjacent to burned areas likely were infested by DFB in 1990 (Pasek 1991).

In fall 1990, brood density averaged 28 DFB per 36 sq. in. sample, indicating that the food resource was being fully occupied by beetles (Pasek 1991). The brood consisting of larvae, pupae, and callow adults appeared healthy and few natural enemies were detected. A population increase of 4-5 times was predicted for 1991 assuming favorable environmental conditions. A cursory examination of the brood in spring 1991 indicated that many DFB (perhaps 75%) did not survive the winter, probably due to prolonged extreme cold temperatures that occurred in late December 1990. The number of trees attacked in 1991 appeared to be similar to the level of damage that occurred in 1990.

The purposes of this evaluation were to assess fall 1991 DFB population levels at several sites on the Clarks Fork Ranger District, and determine the potential for population increase in 1992.

METHODS

Two bark samples (approximately 6 by 6 inches) per tree were removed from a 5-7 foot height on the north and south sides of Douglas-fir trees currently infested by DFB at Camp Creek, the Cathedral Cliffs Sale area, and near Upper Reef Creek on 13-14 November 1991. DBH was recorded for each sample tree. One sample tree at the Cathedral Cliffs Sale site was cored with a increment borer to determine its age. DFB and DFB natural enemies dislodged from the bark sample during removal were identified, counted, and discarded. Bark samples were stored in plastic bags and transported to the Rapid City Service Center office, where they were examined. Length and width of each sample was measured. Because there was little variation, all samples were considered to total 36 square inches of bark surface. Number of gallery starts was counted and total inches of egg gallery was measured for each bark sample. Phloem was shaved with a knife to locate all insects in each sample. Numbers of live DFB brood by life stage and DFB predators and parasitic insects were tallied. Means and standard deviations by sample site were calculated for all variables measured.

RESULTS AND DISCUSSION

Average DBH of sample trees in 1991 was 19.1 in. (Table 1), consistent with the finding that DFB attacks larger diameter trees (Pasek 1990). Mean DBH of trees attacked in 1991 was somewhat smaller than those attacked in 1989 and 1990 (Pasek 1990, 1991), perhaps because most of the largest diameter trees were no longer available for colonization, having already been killed by DFB.

The sample tree at the Cathedral Cliffs Sale site that was cored had approximately 237 annual rings and a DBH of 18.7 in. This tree had grown vigorously for its first 82 years, followed abruptly by 155 years of very poor growth (1:10 ring width ratio).

Mean brood production in fall 1991 differed by site (Table 1). Infested trees near Upper Reef Creek contained fewer brood than the other two sites. In addition, the Upper Reef Creek site was the only location sampled where host tree resistance to DFB development was observed; half of the samples and three of the four trees had pitch-filled DFB galleries with no evidence of brood development. In contrast, mean total brood production at Camp Creek and the Cathedral Cliffs Sale area was 13 and 9 beetles per sample, respectively (Table 1). Such brood production levels are similar to those found in November, 1989 (Pasek 1990), the year following the fire, and suggest that high population levels remain present (Chansler 1968; Schmitz and Rudinsky 1968).

New or callow adults, the usual overwintering stage of DFB, were the predominant life stage in all samples (Table 1). Adults were consistently present, occupying 94% of samples other than those from Upper Reef Creek. Densities of DFB larvae and pupae were far lower

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RESULTS AND DISCUSSION

Mean DBH of sample trees in 1991 was 19.1 in (Table [illegible]) [illegible] [illegible] Pone [illegible] 1990 [illegible] attacked in 1991 was somewhat smaller than the [illegible] attacked [illegible] and 1990 ([illegible] 1990, 1991), perhaps because most of [illegible] trees were no longer available for colonization [illegible] been killed by DFB.

[illegible] at the Cathedral Cliffs Sale site [illegible] was cored [illegible] 187 annual rings and a DBH of 18.7 in. This tree had [illegible] for its first 42 years, followed abruptly by [illegible] poor growth (1:10 ring width ratio).

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Table 1. Douglas-fir beetle brood production per 36 sq. in. of bark surface or samples taken at 5-7 ft., November 1991, Clarks Fork RD, Shoshone NF (mean ± standard deviation).

		Location			
	Aspect	Upper Reef Creek	Camp Creek	Cathedral Cliffs Sale	All Sites
N trees		4	5	12	21
DBH		17.3 ± 3.5	19.4 ± 3.9	19.5 ± 1.6	19.1 ± 2.7
Eggs	Both	0.0	0.0	0.0	0.0
Larvae	North	0.25 ± 0.50	1.40 ± 1.68	2.58 ± 3.32	
	South	0.00	1.00 ± 2.24	1.67 ± 2.56	
	Both	0.13 ± 0.35	1.20 ± 1.88	1.88 ± 2.98	1.38 ± 2.50
Pupae	North	0.25 ± 0.50	1.00 ± 1.22	1.33 ± 2.39	
	South	0.0	0.40 ± 0.55	1.42 ± 4.01	
	Both	0.13 ± 0.35	0.70 ± 0.95	1.38 ± 3.23	0.98 ± 2.51
New Adults	North	1.50 ± 3.00	8.60 ± 4.04	3.75 ± 3.05	
	South	0.25 ± 0.50	14.20 ± 4.66	6.33 ± 5.45	
	Both	0.88 ± 2.10	11.40 ± 5.06	5.04 + 4.52	5.76 ± 5.53
Total Brood	North	2.00 ± 4.00	11.00 ± 5.29	7.67 ± 5.12	
	South	0.25 ± 0.50	15.60 ± 4.33	8.92 ± 6.58	
	Both	1.13 ± 2.80	13.30 ± 5.17	8.29 ± 5.80	8.12 ± 6.50
Gallery Starts	North	2.00 ± 0.82	2.00 ± 1.41	2.58 ± 1.31	
	South	1.75 ± 0.96	2.20 ± 1.10	2.58 ± 1.44	
	Both	1.88 ± 0.83	2.10 ± 1.20	2.58 ± 1.35	2.33 ± 1.24
Egg Gallery Length	North	11.99 ± 5.79	30.59 ± 8.08	24.92 ± 7.66	
	South	9.71 ± 1.94	25.70 ± 13.10	23.88 ± 5.93	
	Both	10.85 ± 4.18	28.14 ± 10.58	24.40 ± 6.72	22.71 ± 9.45
Clerids	Both	0.0	0.0	0.0	0.0
Parasitic Insects of DFB	North	0.75 ± 1.50	9.00 ± 5.79	3.58 ± 4.46	
	South	1.00 ± 2.00	9.60 ± 6.58	0.58 ± 1.24	
	Both	0.88 ± 1.64	9.30 ± 5.85	2.08 ± 3.55	3.57 ± 5.08
***Medetera* larvae**	North	0.0	2.80 ± 3.11	1.75 ± 1.66	
	South	0.25 ± 0.50	2.20 ± 1.48	1.75 ± 1.96	
	Both	0.13 ± 0.35	2.50 ± 2.32	1.75 ± 1.78	1.62 ± 1.90

than adults and more variable between samples. Two trees, one at Camp Creek and one at the Cathedral Cliffs Sale site, accounted for 55% of all immature DFB. No eggs were found. The relative abundance of DFB life stages in 1991 samples differed markedly from those of 1990 when many immatures were found (Pasek 1991), but resembled the brood found in 1989 samples (Pasek 1990).

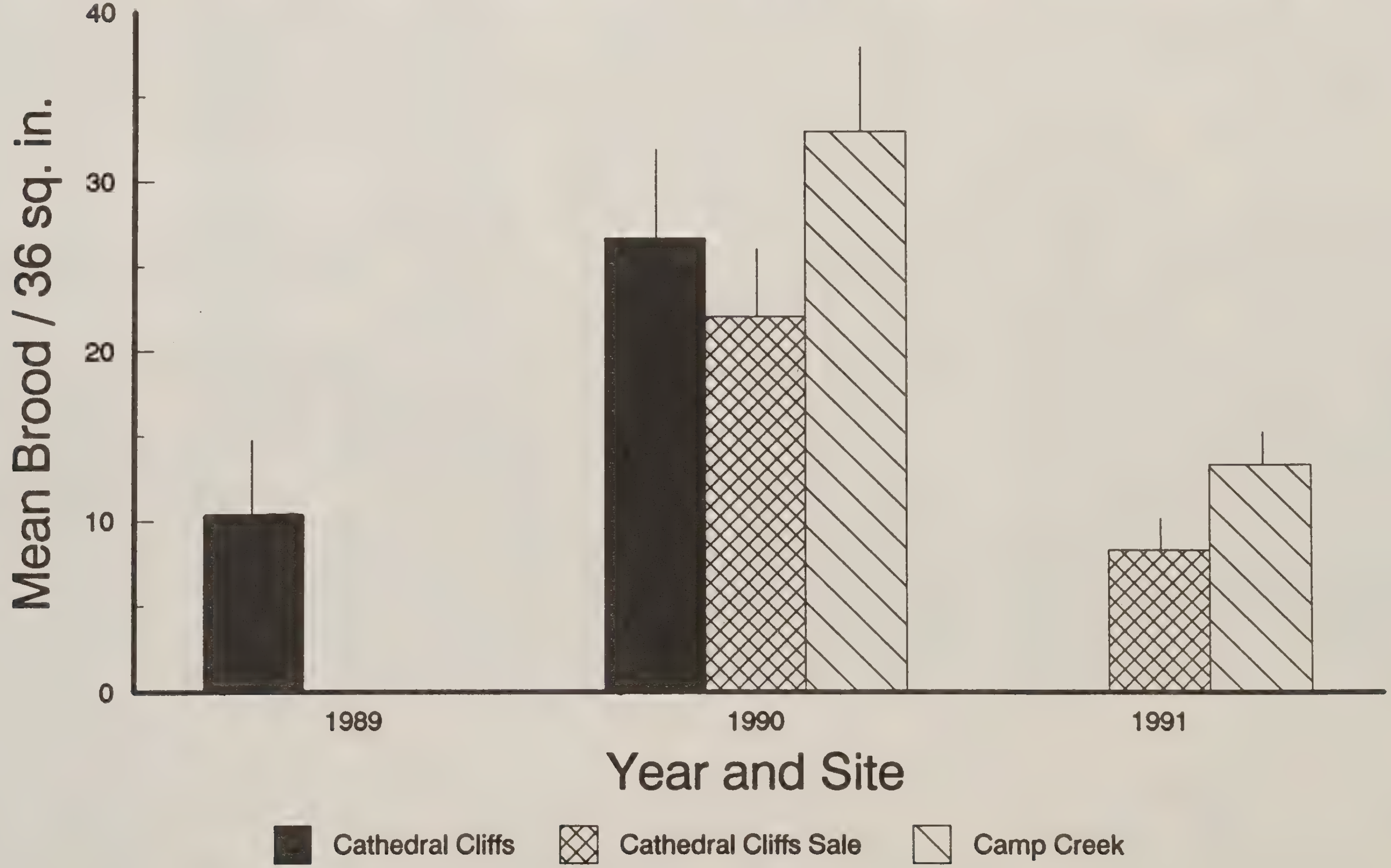
Differences in brood densities between north and south samples were generally small, though larger than in 1990 (Pasek 1991). There was a trend toward more adults on the south side and more immatures on the north side of trees, perhaps because the south side was warmer and therefore development was faster.

Samples averaged 2.3 gallery starts per 36 sq. in. (9.2 per sq. ft.), with little variation (Table 1), indicating uniform attack densities among successfully colonized trees. This compares to a mean of 1.8 gallery starts in 1990 samples (Pasek 1991), and is somewhat higher than the range of 4-8 gallery starts per sq. ft. that is considered to indicate maximum brood production (McMullen and Atkins 1961). Mean total egg gallery length per bark sample varied by site ranging from about 11 to 28 in. per 36 sq. in. (44 - 112 in. per sq. ft.), and reflected the lower brood density near Upper Reef Creek. Attack densities remained high in 1991 relative to the mean total egg gallery length of 80 in. per sq. ft. found in 1990 samples (Pasek 1991) and the range of 30 - 60 in. per sq. ft. that reportedly represents maximum brood production levels (McMullen and Atkins 1961). Some intraspecific competition is likely at the higher attack densities, and may contribute to reduced brood survival.

Presence of DFB natural enemies was common in infested samples. The most abundant were parasitic wasps, particularly cocoons of the braconid Coeloides sp., while larvae of Medetera sp., a predatory fly, were also common. No predatory beetle larvae (clerids) were found in 1991, and few were found in 1990 (Pasek 1991). Samples likely were collected after most clerid larvae had already migrated to the root collar, where they overwinter in the outer bark or duff (Marsden et al. 1981). Natural enemy density showed little variation by aspect, except that two trees at the Cathedral Cliffs Sale site had large numbers of Coeloides sp. on the north, but not the south side. Because Coeloides sp. lays eggs through the bark, it is not uniformly distributed within the tree and usually is more abundant higher up the stem where the bark is thinner (Marsden et al. 1981). At Camp Creek, samples averaged 9.3 parasitic wasps and 2.5 Medetera sp. (Table 1), which nearly equals the mean total surviving brood for that site. While natural enemies were less abundant at the other two sites, mortality from natural enemies was 10-40 times greater than the low levels documented in 1990 (Pasek 1991). The continued presence of large numbers of DFB apparently has allowed natural enemy populations to increase. For 1991 brood, additional DFB mortality caused by insect predators and parasites is expected to be minimal, based upon their life cycles. Natural enemies are likely to attack the 1992 brood in relatively high numbers.

Surviving DFB brood in fall samples, as summarized by Figure 1, displayed a large increase in total numbers from 1989 to 1990, followed by a decline in 1991 to a level similar to levels detected in 1989. The decline in 1991 reflects the heavy overwintering mortality that occurred between fall 1990 and spring 1991. In 1991, an average of about 3.5 DFB were produced per mated pair of adults (8 DFB/2.3 gallery starts per sample) or almost 2 DFB per attacking female. At the Cathedral Cliffs Sale area, about 6 DFB were produced per mated pair of adults, or about 3 DFB per attacking female. Some additional brood mortality can be expected prior to spring emergence of adult DFB, caused primarily by woodpecker predation and weather-caused mortality. In the absence of severe winter temperature conditions, a population increase of about 1.5 to 3 times can be expected for 1992. Although DFB population density declined in 1991, epidemic conditions continue to persist and future population trends will depend largely upon weather and host conditions.

Figure 1. Total Overwintering Brood, 1989-1991
Douglas-fir beetle, Clarks Fork RD, Shoshone NF



ALTERNATIVES

Several methods are available to reduce populations of DFB and the resultant tree mortality. These pest management strategies may focus on the reduction of infested material, reduction of susceptible host material, or prevention of new attacks. The decision to use a particular method should be predicated on considerations of stand conditions, location, management objectives, economic factors, and other pertinent variables.

Alternative 1: **Salvage Harvesting** - Fell infested trees and remove them from the site for mill processing prior to adult DFB emergence. Stands with the highest percentages of large-diameter Douglas-fir should be given priority.

Where to use - Sites with the following conditions are appropriate: accessible to logging operations such as near existing roads or where roads can be readily constructed; less than 40% slope; where disturbance by man will not adversely affect special resource values; and in proximity to high value areas that need to be protected.

Advantages - Beetle broods can effectively be eliminated in small loci by removing all infested trees prior to beetle emergence. Beetle populations in larger groups can be significantly reduced. Salvaging provides a degree of protection to surrounding, uninfested trees by removing a nearby source of attacking beetles, recovers timber volume that otherwise would be lost, reduces fuel load, reduces subsequent hazard from falling trees and inaccessibility to large animals, reduces visual impact of dead and dying trees, and will encourage regeneration and greater diversity of size and age classes across the forest.

Disadvantages - Short implementation time is required; trees must be removed prior to adult emergence in the spring following attack. Adverse disturbance of the site and soil is possible. Salvaging removes tree cover in spots or at a density considered adverse aesthetically.

Alternative 2: **Tree Baits** - Commercially available DFB tree baits containing attractant semiochemicals (aggregation pheromone) can be used to concentrate beetles in trees that can be subsequently harvested. Baits are deployed just prior to beetle flight (May) and baited trees must be felled and removed or destroyed prior to the next adult emergence period (i.e., within one year).

Where to use - Ideal sites for placement of baits would be Douglas-fir trees in and around salvage operations. Baited areas must be suitable for harvest (alternative 1) or mechanical control (alternative 3). Baiting is likely to be most effective in areas where beetle populations are small; e.g., it is useful as a mop-up operation following removal of infested trees. Baiting is not suitable for large population centers; the native beetle population quickly overwhelms the baits in this situation.

Advantages - Baiting may provide some degree of redirection of beetle attacks to trees where salvage can be implemented. Beetles emerging from infested trees that were missed during salvage harvesting in one year may be concentrated in logs or trees for removal the following year.

Disadvantages - Application is generally limited to sites accessible to harvest and where beetle populations are low and relatively isolated from larger population centers.

Alternative 3: **Mechanical Control** - Fell and buck infested Douglas-fir trees and treat them by burning, peeling the bark, or chipping the logs.

Where to use - Use in unroaded areas or on steep slopes that are accessible on foot (or horseback) to logging but where roadbuilding or skidding is undesirable. Sites where no logging company is interested in bidding on the timber or volume is too small to put up a sale also are appropriate.

Advantages - Much of the beetle brood can be eliminated even in the absence of a timber market. Mechanical control provides a degree of protection to surrounding, uninfested trees by removing a nearby source of attacking beetles. It also reduces subsequent hazard from falling trees and inaccessibility to large animals, reduces visual impact of dead and dying trees, and will encourage regeneration and greater diversity of size and age classes across the forest. Potential for site and soil disturbance is less than for alternative 1.

Disadvantages - Mechanical control is labor intensive, does not recover value and volume from trees, leaves a high fuel load on the site, removes tree cover, and requires a short implementation time; trees must be treated prior to adult emergence in the spring following attack.

Alternative 4: **Trap Trees** - Green trees can be felled and left on the site to attract beetles. Felled logs are sprayed with carbaryl in April or May, just prior to the beetle attack period, so that beetles will be killed as they enter the logs. Tree baits can be used on felled logs to increase their attractiveness to beetle attack.

Where to use - Use in small infestation pockets where salvaging, mechanical control, or reentry is impractical. Also use in unroaded areas or on steep slopes that are accessible on foot (or horseback) to logging but where roadbuilding or skidding is undesirable. Sites where no logging company is interested in bidding on the timber or volume is too small to put up a sale also are appropriate. Trap trees may be used as a tool to mop-up a population following salvaging.

Advantages - Use of trap trees concentrates beetle attack away from trees where protection is desired, kills beetles, does not require sale preparation and administration, can be used on sites with steep slopes or where roads do not exist and are not desirable, and is not as labor intensive as mechanical control.

Disadvantages - Use of trap trees does not recover value and volume from trees, leaves a high fuel load on the site, and removes tree cover.

Alternative 5: **Silvicultural Treatment** - To reduce susceptibility in green stands, basal area should be reduced below 80% of normal stocking (Furniss et al. 1981). Mature and overmature stands of Douglas-fir can be harvested. Younger stands should be thinned periodically to improve vigor and reduce moisture stress.

Where to use - This is a preventative treatment that should be considered as an ongoing part of the regular timber program. Due to limited staffing and funding, this alternative is not suitable during an epidemic where resources are better spent on other options.

Advantages - Silvicultural treatment reduces susceptibility of stands to beetle attack, which may limit tree mortality and infestation size in the event of a future increase in beetle population.

Disadvantages - This alternative is not suitable for sites where harvesting activity is not desirable, such as in wilderness, on steep slopes, or where visual quality would be adversely impacted.

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Disadvantages - [illegible] installation [illegible] salvaging, chemical control, [illegible] impractical. Also [illegible] slopes that [illegible] logging but where roading [illegible] undesirable. [illegible] interested in [illegible] small to put up a [illegible] approval [illegible]. Trees may be [illegible] following salvage.

Advantages - Use of [illegible] attack [illegible] from [illegible] kills beetles, does not require sale [illegible] administration, can be used [illegible] sites with steep slopes or where roads do not exist and are [illegible] desirable, and is not as labor intensive as [illegible] control.

Disadvantages - Use of trap trees [illegible] value and volume from trees, leaves [illegible] on the [illegible], and remove [illegible] tree cover.

[illegible] 5: Silvicultural treatment: To reduce susceptibility [illegible] green stands, basal [illegible] should be reduced below [illegible] of normal stocking (Furniss et al. [illegible]). Mature [illegible] overmature stands of Douglas-fir can be harvested [illegible] at [illegible] should be thinned [illegible] vigor and reduce susceptibility [illegible].

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[illegible] treatment [illegible] stands to [illegible] and infested [illegible] in the [illegible] beetle population

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Alternative 6: **Protection of High Value Trees** - Prior to beetle flight in early spring (April or May), the boles of valuable trees can be sprayed with carbaryl to prevent DFB attack.

Where to use - This method would be appropriate for use in and around campgrounds and private homes. Trees must be of high value. Insecticide application is not effective for trees that have already been infested.

Advantages - Insecticide application provides a degree of protection not currently available through other mitigation strategies. Carbaryl has a low mammalian toxicity and low residual activity, which means it remains in the environment for a short period of time.

Disadvantages - Efficacy for protection of Douglas-fir needs to be demonstrated by a test prior to operational usage. Material is toxic to other insects as well as to DFB. Many citizens have concerns about environmental contamination and safety. Insecticide application may not effectively reduce the existing beetle population, is expensive if very many trees are treated, and size of treatment areas need to be small due to cost and labor considerations.

Alternative 7: **Repellents** - A granular controlled-release formulation of the DFB antiaggregative pheromone, 3-methyl-2-cyclohexen-1-one (MCH), can be broadcast or aerially applied to stands where protection is desired. This alternative currently requires an experimental use permit (cleared by EPA through 5/93); registration of the material with EPA is not yet completed.

Where to use - The method is most suited for high value and inaccessible stands that are not currently infested but are threatened by nearby beetle populations.

Advantages - MCH is nontoxic; it is a natural chemical that is produced by DFB. Use of MCH is a promising method of preventing new attacks.

Disadvantages - MCH does not directly reduce the existing beetle population. Granular application distributes plastic pellets into the environment. Availability of the material may be a problem. MCH is not yet registered and has not been tested to determine the efficacy for protection of standing, green trees.

Alternative 8: **Do Nothing** - Accept tree mortality caused by DFB as a natural phenomenon.

<u>Where to use</u> - Use where other control alternatives cannot be effected or are not desired. This may be the only viable alternative for infested stands that are inaccessible, areas designated as wilderness, and sites where the visual and erosive impacts of harvesting are a major concern.

<u>Advantages</u> - No unnatural site disturbance or introduction of foreign materials into the environment will occur. Change in vegetation follows a natural event.

<u>Disadvantages</u> - The no action alternative allows the beetle population to continue to increase and threaten additional sites. Tree volume and value is lost, visual quality is adversely affected by dying and dead trees, fuel load increases, tree hazard increases, inaccessibility to large animals increases with time as trees fall over, and tree regeneration is inhibited due to shading by remaining dead trees and lack of seedbed preparation.

RECOMMENDATION

Alternative 1 should be considered wherever feasible and economical within the suitable timber base to remove as many infested trees as possible. Newly-attacked trees need to be located each summer during the course of the epidemic and salvage sales need to be put in each year for several years until DFB populations are satisfactorily reduced at sites where management objectives would otherwise be adversely affected.

Alternative 2 may be appropriate for some sites where low level populations of DFB can be lured a short distance in a particular direction so that infested trees are accessible for harvesting, or where baits can be used to lure DFB to log decks for subsequent removal. Successive baiting and salvaging may be needed. Luring DFB to standing, green trees does not work well in epidemic situations where the natural pheromone of the beetles overwhelms the artificial baits.

Alternative 3 can be effective for treating small infestations near high value areas or homes.

Alternative 5 should be considered for long-range management planning to increase the health of forest stands and reduce susceptibility to DFB attack.

De-decking. [illegible]

[illegible] Use where [illegible] cannot be [illegible] are not controlled. This may be the only viable alternative for infested stands [illegible] where possible, [illegible] designated [illegible] where the visual and [illegible] are a major concern.

Advantages: [illegible] introduction of foreign materials [illegible] will occur. Change in [illegible]

Disadvantages: [illegible] no action alternative [illegible] beetle population to continue to increase [illegible] additions, stream [illegible] visual quality is adverse [illegible] trees, fuel load [illegible] inaccessibility [illegible] as trees fall over [illegible] due to shading by [illegible] seeded plugs [illegible]

REC[illegible]

Alternative 1 should be considered wherever [illegible] in the suitable timber base [illegible] infested tree [illegible]. Newly attacked trees [illegible] located [illegible] the epidemic, and salvage [illegible] [illegible] years until DPB populations are [illegible] where management [illegible]

[illegible] be appropriate for some sites where [illegible] be found [illegible] that infested trees are accessible for harvesting; or [illegible] to lure DPB to log decks for [illegible] Sanitation cutting and salvaging may be needed. [illegible] ling green trees does not work well in epidemic [illegible] beetles overwhelm the [illegible]

[illegible] treating small infestations [illegible]

[illegible] and for long-range management planning [illegible] to reduce susceptibility to [illegible]

Alternative 8 may be selected of necessity in much of the Clarks Fork Ranger District because of the extensive areas of wilderness affected by the Clover Mist Fire, the presence of inaccessible areas, the concern for visual and erosive impacts of harvesting options, and the constraints on time and manpower available to treat damaged sites.

Land managers need to develop site-specific plans to manage stands to reduce the impact of DFB where feasible. Alternatives should be carefully weighed in relation to site-specific characteristics. Forest Health Management personnel will continue to assist in reassessing DFB population and damage levels as needed during the course of the infestation.

District and Forest personnel are commended for their efforts thus far in attempting to mitigate DFB populations in key forest management areas.

ACKNOWLEDGMENTS

Appreciation is extended to everyone who has assisted with the Douglas-fir beetle situation on the Clarks Fork Ranger District. Ken Lister provided technical assistance by helping locate infested areas, collecting bark samples, and providing input on sampling methods, management alternatives, and recommendations. Dennis Carlson and Michael Wagner also assisted with the collection of bark samples. Dennis Carlson assisted with examination of bark samples and data collection.

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